

## EXECUTIVE SUMMARY

The **Expeditionary Warfare Integrated Project** represents the combined effort of more than 70 students and 18 faculty members from seven different Naval Postgraduate School curricula representing all five US uniformed services and allies from Singapore, Turkey, Greece, Tunisia, and Sweden. This project was the result of OPNAV N7 tasking directing NPS' Wayne Meyer Institute of Systems Engineering to use a top down, system of systems approach to examine future Expeditionary Warfare operations in terms of current and emerging operational concepts.

The project results were obtained using a Top Down, Bottom Up approach. The Top Down approach examined current and proposed operational concepts such as Ship To Objective Maneuver (STOM) and Sea Basing. We performed a Functional Analysis of the Expeditionary Warfare mission using Functional Flow Block Diagrams and Integrated Definition Language notation to define the capabilities required to perform Expeditionary Warfare. In order to determine the capabilities available for Expeditionary Warfare, the Bottom Up approach examined the current and planned Navy and Marine Corps expeditionary force architectures, referred to in the tasking as the "programs of record."

We identified capability gaps by comparing the capabilities available and the capabilities required. Once these gaps had been defined and prioritized, we allocated the most important of them to platform solutions and generated conceptual design requirements for a family of ships capable of supporting STOM operations through a Sea Base, a long range, heavy lift aircraft, and a multi-tiered family of intelligence, surveillance, and reconnaissance (ISR) systems to various supporting NPS design teams. The ultimate result was our conceptual architecture, a mixture of planned and conceptual platforms designed to be capable of fully implementing the Ship to Objective Maneuver and Sea Basing doctrines.

In order to evaluate the performance of our conceptual architecture against the current and planned architectures, we generated a large scale, high resolution dynamic model capable of tracking personnel, vehicle, and material flows from CONUS through the Sea Base and on to the Objective at the individual Marine, vehicle, and supply

commodity level. Utilizing design of experiments, we compared the three architectures' ability to project combat power ashore and determined the effects of weather, mine warfare, distance to the objective, and personnel and vehicle attrition on the ability to execute an expeditionary operation.

Our metric was Combat Power Ashore, the sum of Combat Power Indices assigned to individual Marines, combat vehicles, and artillery pieces placed at the objective. Each architecture's fitness was measured by the time required to place combat power at the objective under the influence of the four previously mentioned factors. Our analysis used two measures of performance: the Time to Build Up Advanced Force (TAF), which represented the time to insert one company of infantry and supporting equipment at the objective and Time to Build Up Desired Force Level (TBU), which represented the time required to place 80% of a MEB sized Ground Combat Element and their supporting equipment at the objective. The sustainment measure of performance was the mean square error in days of supply at a particular location, which represented a deviation from a desired level of supply.

Our major conclusions included:

- The Time To Build Up The Advance Force (TAF) for each architecture was insensitive to the effects of weather, mines, and distance from the objective.
- The proximity of the ships to the objective and weather conditions are the main influences on the Time To Build Up To The Desired Force Level (TBU).
- Under good weather conditions, commencing the MEB assault from a greater distance at sea does not increase TBU significantly.
- Aircraft combat survivability is critical for successful sustainment of the objective, particularly in STOM operations where a greater proportion of supplies travel by air. Combat survivability can be improved through a

combination of threat suppression, use of escort aircraft, and/or the incorporation of robust aircraft combat survivability into their initial design.

- The Current Architecture, with the accompanying Iron Mountain, while it takes the longest time to build up forces ashore, is the most robust in sustaining the objective, if the operational commander is willing to accept the accompanying operational pause and the threat conditions permit. This is primarily the result of the Iron Mountain's large overland transportation capacity, which was not affected significantly by weather or the attrition modeled in our scenario.
- Sea Basing appears to be a viable operational concept, since the model showed the Planned Architecture was able to sustain the objective through the Sea Base as well as the Current Architecture, but only under good weather conditions. The reduced surface craft sea keeping, loading capacity, and speed reduction caused by heavy weather meant a Sea Base comprised of the Planned Architecture had difficulty maintaining the required flow of supplies in inclement weather. Additionally, the Planned Architecture's combat force projection was distance limited, based on planned transporter capabilities, to approximately 175 nm from the Sea Base.
- Under all conditions, the Conceptual Architecture was able to project forces ashore in the shortest time, since its increased number of MV-22 and conceptual long range, heavy lift air assets were better able to project forces up to the 275 nm from the Sea Base required by doctrine.
- The longer transport ranges and larger number of aircraft required lead to very high fuel consumption rates, which demand more frequent fuel deliveries to the Sea Base.

- While large numbers of aircraft are required to implement STOM and re-supply from a Sea Base over the long distances envisioned in the doctrine, there remains a need to retain an effective surface craft transport capability to project high volume and weight loads, such as the M1A1 tank, ashore.

The N7 tasking also requested the examination of several excursions, the most significant of which involved the effects of speed and the impact of High Speed Vehicle (HSV) platforms on Expeditionary Warfare. We examined a Joint Venture class HSV as an alternative to a Fast Support Ship large bulk cargo ship.

- We determined that at its current cost, speed, and payload, the HSV was not an effective replacement for an FSS to resupply the Sea Base.

To break even on cost, the HSV would need to be capable of transporting full loads at speeds in excess of 55 kts or carry at least 1.5 times the current payload without increasing the per unit cost.

A second excursion examined the impact of Sea Basing.

- We determined that the increasing requirement to transfer materials and Marines by air increased the number and size of the air transporters required and placed a premium on aircraft combat survivability to ensure the continued flow of materials.

The final excursion examined the impact of reduced footprint ashore.

- Our analysis showed the most significant factors in reducing footprint were the air transportability of supplies and increased reliability of equipment.

As part of this study, we were not trying to generate operational requirements nor write doctrine. This study was an academic exercise and its results have not been endorsed by either the Navy or the Marine Corps. Additionally, while we did consider cost as a design factor, we did not trade away system capability in order to fit the Conceptual Architecture into the POM. Further, we are not advocating “throwing away” our legacy systems; our conceptual architecture is merely an attempt to show what one incarnation of the capability to fully implement STOM from a Sea Base might look like. Finally, our scenarios were created purely to facilitate our analysis and do not represent the official views or policy of the Navy, Marine Corps, or any government.

Because of time constraints, we did not examine all of the capability gaps we identified. For example, we did not conduct an analysis of the costs and benefits of, or the design of systems for, providing precision and volume fire support from the Sea Base. We also did not conduct a detailed examination of C4ISR systems and their requirements to support STOM. Finally, we did not conduct analysis of more detailed operational concepts such as “Sense and Respond Logistics” and “Enhanced Networked Sea Basing.”

The initial tasking, to examine Expeditionary Warfare in its entirety, was extremely challenging, since virtually any military activity can be relevant. It was obvious from the start that we could not cover all elements of Expeditionary Warfare in depth. Despite the need to curtail some aspects of the inquiry, we concluded that our approach produced results useful to our sponsor and that our methodology provides a jumping off point for additional paths of inquiry.

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